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Summary

The only way to resolve the overstress problem is to increase significantly the structural stiffness by adopting the principle constructive improvements:
- bigger cross section of the impact beam
- rigid boundary condition
- door truss as bi-functioning system
- compound construction of the adjacent doors with all post sections into whole car side
- compound construction of both car sides via the roof and vehicle floor
- impact springs for absorbing the side impact energy
- safety mechanism to prevent the door locks from opening due to the inertia force on collision and/or overturn

Cost cuts related to manufacturing and investments will be achieved by:
- two modular door assembly concepts
- using standard items and fewer parts
- minimizing the number of the beam types for doors of different car classes
- a single construction for the passenger protection on collision and/or overturn

Description

Specification:
Vehicle door for car and truck

Subspecifications:
- Increasing the structural stiffness by adopting twice the compound construction of the adjacent doors with the A-, B- and C- post sections and of the both car sides with the roof and vehicle floor via the corresponding reinforced elements
- Door truss replacing the impact rods and the structure supporter comprising reinforced girders, ribs, plates
- Modular door assembly at the production cell
- Improving the retaining function or retaining-/ lock function with the protection against vehicle theft as side effect
- Safety mechanism to prevent the door locks from opening due to the inertia force in the event of collision and/or overturn
- the locking plate in the event of collision and/or overturn
- Impact springs for absorbing the side collision energy

Cost cuts will be achieved by these new inventions as:
- modular door assembly concepts with the advantages of smaller width of the assembly line and fewer accidents. Assembly workers can work safely if the chassis without panels is being moved along the assembly line.
- use of standard items
- minimizing parts by replacing with bi-functioning parts
- standardising to minimize the number of the beam types for doors of different car classes
- a single construction, manufacturing, testing, assembling related to a sole material supply for enhancing the passenger protection on collision and/or overturn

Among appr. 1.9 million driving accidents registered by the German police during the year of 1993 were 9913 dead occupants. Unexpectedly, new models and two vans have failed completely the front collision and offset crash tests carried out by Auto Motor und Sport (published in 24/93 issue) and ADAC (4/94 issue), respectively. Hence, it is justified to raise the question whether three patent applications used as *standard references (documents)* for more than two decades for citing new applications can stand the rigorous review concerning Technical Mechanics. One of these *references* was cited for the review of the incontestable Jaguar Patent EP 0472284A1. However, in comparison with Jaguar Patent (Chap. 1) with a total verdict of "*Category A*" the new patent application shows determining enhancements regarding passenger protection by embodying different proposals with regard to cutting the manufacturing and assembling costs.

The inventor presents the structural analysis
- in Chap. 8 with a view to convenient reference in Fig. 22 concerning the front collision and
- in Chap. 6, 15, A7, A9 for convenient view in Fig. 1, 23 and 24 concerning the side collision.

All 13 patent applications listed in the Chap. "Technical Review" dealing principally with front- and side collisions were under review.

The result of this review is absolutely catastrophic:

- Six doubtful inventions (Chap. 5, 8, 9, 10, 11 and 15), incl. *these three standard references.*
- Four inventions with limited applicability (Chap. 2, 4, 12 and 13).
- Regarding the inventions of passenger protection only three patent applications from Jaguar , BMW and Porsche, respectively, satisfy the criteria concerning "structural-design and manufacturing concepts" characterised by advantages and disadvantages. As sole inventor Jaguar has discovered the problem of the present boundary condition (Chap. 1, N1 and N3) concerning the front collision.

For more than two decades R&D work based on these doubtful and "inventions" with limited applicability has missed definitely the goal of passenger protection. For delivering the experimental verification the inventor has evaluated the Crash Tests and newspapers reporting about collisions. The results from evaluating the state of deformation in Chap. 8e, 9e, 10d and 11 coincide with the load cases in Chap. 8a, 8b and 8c.

The state of deformation of the totally deformed car will be analysed by applying the knowledge gained in co-operation with the newspaper Wiesbadener Kurier of 28.1194, the accident protocol, the statements of the police chief, inspecting the three cars involved in the fatal accidents and evaluating the photos shot during the inspection.

On 27.11.94 at 1.10 am a car driving along the highway Frankfurt-Köln swerved without no explicable reason to the left against the edge of the kerb (curb) and against the central barrier. Consequently, the back wheel shaft of the driver side was broken and the structure section above this back wheel was totally deformed. Equivalent to the side collision force S in Fig. 1 the force of reaction acting on this structure section cause an overturn moment rotating the car about the axis of the wheels from the co-driver side. The impact energy represented as acting force -V (Chap. 8c) with angle greater than 90^0 in z-x plane of Fig. 22 was absorbed primarily by the A-, B- and C-post sections of the driver side.
A similar deformation situation arises according to the load case in Chap. 8c. The collapse of the A-,B- and C-post sections as well as the total deformation of the upper structure of the driver side were far worse than the upper and lower structure of the co-driver side. The conventional locks (Chap. 8e) could not withstand the loading. During the several overturns the tailgate door after being torsionally deformed stayed open and the front doors opened and closed alternatively. In spite of the immense expenditure of energy causing the collapse of the passenger cell, the fracture of some parts and the overturn moment there was still enough energy left for hurling the four passengers out of the totally deformed car and for overturning this car several times crossing the lanes until being stopped after crashing with the outer barrier.

The Ford invention DE4336351 B60N2/42 deals with an underneath seat activated by the front collision to intercept the passenger. It characterises the problem of the downward movement of the seat-belted passenger out of his seat. This is a serious problem during overturn.

Being hurled underneath the central barrier a lady was run over by two cars travelling in the opposite direction of the highway. She was dead on the spot.
From the state of deformation in relation to the fatal and heavy injuries the following conclusions can be derived:

U1 Concerning the totally deformed car registered 2-3 months ago it was the winner as well as the best among the compact cars being crash tested by the independent institutions. The improvement of the survival chance is attributed to the existing specifications of front collision and offset crash tests. However, in order to increase the survival chance it is necessary to specify the following design criteria.

U2 Having passed the Crash Tests with excellence those conventional door locks could not withstand loading in the event of collision and/or overturn. Whether it was broken or detached from the mount, the inventor could not ascertain because the police forbad him to touch the cars subjected to the prosecuting investigation. As experimental verification the state of the door lock whether broken and/or detached shows an excellent agreement with the load cases according to Chap. 8 to calculate the resultant stress.

To summarize: The door locks as well as the mounts of the door locks and of the reinforced elements (Chap. 8e, 9c, 10c, N3) prove to be absolutely useless. As ultimate objective is a complementary requirement that the doors and tailgate door may not open by themselves in an accident. This requirement will be met by the new concept for retaining blocks (Chap. N2 , N3 and Definition in Chap. A5a) with or without the locking function.

U3 Equivalent to the side collision force S in Fig. 1 the force of reaction acts only on one door. On contrary to the twofold embodiment of the compound construction the whole structure side in co-operation with the roof and vehicle floor is under load. This embodiment is very useful too for passenger protection on collision and/or overturn.

To summarize: The present passenger cell proves to be absolutely useless. After the collapse of passenger cell the installed airbag can not save the occupant´s life either. Consequently, such new models (Chap. 9e ,10d and 11) failing the front collision and offset crash tests should not be allowed for road traffic!

A complementary requirement is specified for the new patent application:

"Reducing the three dimensional displacements, in x-, y- and z-direction in all Figs., to increase the chance of survival "

In order to avoid overstress four steps are incorporated into an embodiment of the new patent application (Chap. N) to increase the structural stiffness (Chap. N6) as well as to distribute the stress. Hence, the three dimensional displacements are minimized.

U4 In order to avoid torsional deformation the new invention provides retaining blocks (U3) for clamping the tailgate door with both car sides of a car in co-operation with an enhanced door lock (U2).

U5 Two dead and seven heavily injured occupants at the above-mentioned accident and four dead in a German luxury class car after a front collision with a truck on the country road B260 reported by Wiesbadener Kurier of 30.09.94 are the consequences of the wrong conceptual R&D work related to passenger protection. What kind of result should be expected from collisions, particularly on the highway?

U6 If the new inventions (Chap. A6) had been realised, hypothetically, life could have been saved!

Technical Review

1. Jaguar Patent Application of 17.07.91 under EP0472284A1, GB9018350 with the following proposals:

- Impact rod termed as tie bar with costly manufactured keeper plates as clamping means for transmitting *tensile/compressive and torsional loads* from the A-post section to the B-post section.

Compared with the retaining blocks of the new invention the manufacturing costs for Jaguar clamping means are far higher to meet the precise coaxial alignment between both termini of the tie bar with the keeper plates, respectively. These retaining blocks satisfy the rigid boundary condition, hence, *tensile/compressive-, shear-forces, bending moments and torsional moment can be absorbed.* By applying the embodiment of four steps (Chap. N6) the structural stiffness is increased much more than the Jaguar single tie bar.
Beside that, clamping components of Jaguar like solenoids and bifurcated keeper plates are too expensive for car mass production.
For the rear door in co-operation with the C-post section this invention is impracticable. There is no space to accomodate these two voluminous clamping means together in the B-post section. Due to space and constructive restrictions only *structurally undersized* tie bar with round cross section can be only adopted because of the guiding function for the purpose of engaging (clamping) between its termini with the keeper plates of the A- and B-post sections, respectively. Compare to the arbitrary and bigger cross section of impact beams illustrated in Fig. 6 and 7. After the proper adjustment of both clamping means it can happen that the conventional lock will not engage anymore with the catch means. By assuming of a large tolerance zone for each pair of both clamping means the solenoid activates the clamping between the holes of the terminus with two pins at the B-post section and between the other terminus with the rectangular recess at the A-post section. The new invention (Chap. N) resolves these technical obstacles by developing far cheaper clamping means with attributes of customer friendlier operations of adjusting and adapting (Chap. A13, A14) and smaller size, but greater stiffness (Chap. A4, A5a).

2. Invention with limited applicability of Mannesmann Patent Application of 01.10.91 under EP0479401A1, DE4031679, DE4133144 with the following proposals:

- Impact rod with special termini (ends). With great and costly manufacturing efforts by hot forming the surfaces of both termini must be shaped parallel to the centre line of the rod.

How much would the production costs be for shaping by hot forming the surfaces of both termini to meet the parallel surface permissible allowances and the drilling distance tolerances of the mounting holes? How much are the manufacturing wastes and the assembling costs ? The new invention resolves these handicaps by mounting a door hinge to one terminus and providing the other terminus with a retaining orifice. Furthermore,

standard beams can be put into use. Rod is a subspecification of beam according to Technical Mechanics and FEM.
A cross section with two different lengths is attributed with the biggest moment of resistance along the axis of the shorter length, hence, the vector of the impact force is usually in line with the axis of the bigger length. Contrary to this common opinion the application line illustrated in Fig. 2, 5, 7 and 8 is wrong.
The consequences (Chap. 8e) arise because the door locks can not withstand the load cases according to the Chap. 8a, 8b and 8c. Compare with countermeasures according to the Chap. N6. The benefit from this invention in relation to expenditure of costs is outlined in Chap. N3.

3. BMW Patent Application DE4125299A1 of 31.07.91 describes the use of laminated leaf springs to absorb the side impact energy with the following proposals:

- Under the assumption, that the applied force on side collision is acting on the *leaf centre,* the both leaf ends guided by their attachments will extend with equal displacements in order to strut evenly against the A- and B-post section.

The new invention provides impact springs for absorbing the side impact energy acting with *arbitrary direction on arbitrary point.* These conditions can not be met by the BMW invention. Without those expensive BMW guidance attachments the springs of the new invention are cheaper to be manufactured and easier to be installed.

4. Invention with limited applicability of Daimler Benz Patent Application DE 3425777A1 of 13.07.84 with the following proposals:

- Due to the deformation of the outer covering (door panel) the strut girders are in contact with their corresponding reinforced plates.

The consequences (Chap. 8e) arise because the door locks can not withstand the load cases according to the Chap. 8a, 8b and 8c. Compare with countermeasures according to the Chap. N6. The benefit from this invention in relation to expenditure of material, labour and cost is outlined in Chap. N3.

5. Doubtful Invention of Daimler Benz Patent Application DE 2836213 of 18.08.78 with the following proposals:

- The spherical pins threaded in the reinforced rods of the front and back doors strut against the corresponding surfaces of the holder mounted at the B-post section.

The adjusting condition "big clearance between the pin and the surface" on page 2 / 3.section must be regarded as problem of adjusting (Chap. 8e). Definitely, this invention ends in failure because these reinforced rods slide out of the corresponding surfaces being under the single load case related to torsional moment M_y about the y-axis (Chap. 8c) or bending moment M_b (Chap. 8a). Subjected to the load cases according to the Chap. 8a, 8b and 8c the doors are overstressed, hence totally deformed. The benefit from this "invention" in relation to expenditure of material, labour and cost is outlined in Chap. N3.

6. Porsche Patent Application EP 0423265A1 of 27.08.90 with the following proposals:

- On side collision the device (25) of the reinforced ledge mounted to the lower door edge illustrated in Fig. 1 hooks (clamps) with the orifice of the reinforced plate along the sill section (18).

Concerning manufacturing, costs saving and effectiveness this invention of side collision protection is better than those four Daimler Benz Patent Applications of front collision protection.
Since the deflection at the middle of the door (h_1 in Fig. 1) is the greatest and the deflection line depends on triple of the ratio of door heights, this invention is effective for passenger protection of sport car due to doors of small height being subjected to small side impact energy. Missing the clamping means of the upper door edge with the roof (17) is responsible for the overstress exerted by the force Z_T in Fig. 1 on the door lock. The new invention (Chap. N) resolves these technical obstacles

- by placing an impact beam or beams as well as reinforced elements (10.1 and 10.2 in Fig. 1) at the middle of the door and
- by embodying twice the compound construction for stress distribution and for multi-supports (Chap. A6) illustrated in Fig. 23 and 24.

On the basic comparison regarding the bending and torsional stiffness the impact beams are superior to the Porsche reinforced plates. The other three steps of increasing the structural stiffness (Chap. N6 and A7, Fig. 1 and 23) show the advantage towards Porsche invention. By adopting these technical steps the deformation as well as the stress can be lowered significantly.

7. Volvo Patent Application EP 0291107A1 of 14.04.88 with the following proposals:

- Door assembly by inserting a carrier unit into the cavity between the outer and inner panels from *back* to front (opposite to the y-direction illustrated in all Fig.).

In order to build such carrier unit a carrier plate is needed as mounting base for two undersized rods, the window pane, window guides etc. As significant and advantageous differences the door truss of the new invention is a self-supporting unit. Consequently, the outer panel and other door parts can be attached directly to the bigger sized impact beams. Chap. A8 and A8a describe the other advantages.

8. Doubtful Invention of Daimler Benz Patent Application DE 1755661 B2 of 06.06.68

In order to formulate a model, usually referred to as structural idealization, for all structural elements illustrated in Fig. 22 the following assumptions as well as idealization must be specified:

- let the front impact force 2F along the centre line of the car, illustrated as C_L in Fig. 22, replace the uniform loading due to the impact energy.
- let each symmetrical car side as structural half underlie the half of impact force F upon front collision between two cars with bumpers of the same height.
- with regard to the prerequisite for the invention (column 2 / row 16-19) "*both rods are in one corresponding straight line parallel to C_L or to y-axis*" let the rod (9a) replace both rods (9,16) of the adjacent doors with same length. Hence, the B-post section coincides with the middle of this substitute rod (9a).
- let rod represent every structural element under the same load cases.

8a The "invention" noted as I and II in Chap. 8e are in contradiction to the following two cases:

1. In the x-y plane of Fig. 22. The A-post section is under load of the rotating moment $M_z = -H*b$. On the contrary to the " invention" the rod (9a) at the B-post section is subjected to the loading consisting of $M_b = -H*b$ and H and to the maximal deflection. By increasing the impact energy buckling and/or detaching from the mount occur.
2. In association with dripping form ("Tropfenform") due to small drag coefficient the chassis has been designed with unequal front/back inner widths as 1430/1415 mm of Mercedes C180 and 1425/1400 mm of AUDI A6 listed on page 49 of 23/94 issue published by Auto, Motor und Sport. Consider the width b = 800 mm and the distance s = 10 - 30 mm between the hinge and the mount, the decrement or increment of the bending moment is calculated from the ratio s/b = 1.3 - 3.9 %. The influence is neglectable!

8b In the z-y plane of Fig. 22. The moment $M_x = H*h$ about the x-axis is replaced by a pair of forces $H_A = (H*h)/l$ with the lever arm of l. Using the equilibrium condition for moments two forces of reaction are obtained: $V_A = (V*l_C)/l$ and $V_B = -V_A + V$.

Acting in z-direction with respect to the sign are three shear forces: -V, (H_A + V_A) and -(H_A + V_B). These forces exert bending moment on the structural half as well as the rod (9a) along the y-axis. This rod as well as the B-post section are subjected to bending stress. The "invention" noted as II in Chap. 8e is in contradiction to this thesis. Readers unfamiliar with such stress calculation are referred to the Chapter "shear forces, bending moment and moment areas" of the standard references as Dubbels, Hütte and Tech. Mechanics manuscripts for the 2nd Semester.

8c In the z-x plane of Fig. 22. The rotating moment $M_y = V*b$ about the y-axis acts as torsional moment on the structural half as well as the rod (9a) and as bending moment in the z-x plane of the force V. The rod (9) with the termini at the A- and B-post sections is under load of this torsional moment. Again the "invention" noted as II in Chap. 8e is in contradiction to this thesis.

8d Calculating all these three load cases by applying the Mises hypothesis yields the total stress. With respect to this hypothesis the total stress of the B-post section is a superposition of the bending moment M_b , the buckling force H , the bending moment according to the load case Chap. 8b and the torsional moment M_y. Being generalised this stress calculation is valid for structural element (rod, panel or sheet, plate, shell, solid element) and for door structure supporter. See solutions for the boundary condition in Chap. N1, N2 and for the embodiment of stress decrease in Chap. N6.

8e Referring to the listed EP 0472284, FR 2207039 (further information in Chap. 9c), FR 2257449 (further information in Chap. 10c) and DE 2836213 the problem of adjusting for the functional locking is solved improperly by the constrained allowance for a large tolerance zone because the functional locking is of utmost importance. Subsequent to this technical solution relative big clearances must be provided for tolerance zone between the mount (8) and the lock hook (6), in general terms between the orifice and the block. These so-called unavoidable tolerances put the engaging out of effect by detaching from the mount (Chap. U2). The state of deformation is instable due to structural fatigue failure of the termini and/or buckling failure of the undersized reinforced elements and/or torsional deforming. Generally, the outer and inner panels of a door and the tailgate door are subjected to buckling too. In state of the totally deformed front doors the rest impact energy transmitted by the buckling A-post section can be absorbed solely by the passenger cell. After the collapse of the passenger cell the remaining rest energy deforms the occupants. Airbags cannot help here!

The Offset Crash Test by Auto Motor und Sport (in 19/91 issue) delivers the identical states of deformation of two cars from the same type produced by the patent proprietor. The load cases according to Chap. 8a, 8b and 8c are responsible for the state of deformation:

I. In comparison with the *deformed* front door the following parts have *not* been deformed: the back door, C-post section, the back fender, the roof section above the back door.

II. Due to *not transmitting* the impact energy the state of structural failures occured between the A- and B-post sections as detaching the front door from the mount (verified by a side gap between the front door edge and the back door edge) due to the total stress at the B-post section according to Chap. 8d, buckling of the roof, torsional deforming of the upper frame of the front door, buckling of the A-post section, the heavily deformed outer panel in the area of the front door hinges.

III. *The fact, that the structural stiffness is not increased,* is substantiated by both above cases!

In contradiction to these evidences are three conjectures of Dr. Reidelbachs "invention" as followed:

I. (column 2 / row16-27): "*direct transmission of the forces acting along C_L or to y-axis through the doors by one corresponding straight line parallel to C_L to increase the structural stiffness..*".

II. (column 1 / row36-44): "*in an accident the doors will* thereby *forced open*" and (column 2 / row25-26): "*the stress at the B-post section is not noteworthy*"

III. (column 2 / row25-26): "*increasing the structural stiffness*".

The theory in reference to in Chap. 8a, 8b, 8c, 8d and the experiment by Crash Test verify the uselessness and the failure of this "invention". The benefit from this "invention" in relation to expenditure of material, labour and cost is outlined in Chap. N3.

9. Doubtful Invention of Renault Patent Application FR 22 07 039 of 17.11.72

9a page 1 row 33-35 ; 2nd claim: L´élément de renfort as "supérieur" reinforced element (1) is a plate (la semelle) with cross section increasing along the y-axis. The biggest cross section is in the middle of the element (8) shown in Fig. 1. Thereby the deflection of the mid-element is correctly diminished as illustrated in Fig. 22. This embodiment is inapplicable for both termini. On the other hand the cross sections of the termini are not reinforced, so the stress is still the *highest* at the same level! Referring to in Chap. 8a this terminus at the B-post section is subjected to the loading consisting of by M_z as well as by H and to the maximal deflection. See Chap. 9c for detaching from the mount.

9b page 3 row 26-30 and 4th claim: Regarding the highest stress at the same level the problem of the B-post section arises at the construction with the reinforced element (2) from panel with very complicated sectioning (18) in "zig-zag" profile (la bande du tôle pliée au zig-zag sensiblement shown in Fig. 3), illustrated as part of the back door in Fig. 22.

9c 1st claim: Concerning the stiffness increase the mounting of two overlapping reinforced elements with two orifices for each element is completely useless due to the problem of fivefold tolerance zones for the mounting pair door lock / block and the four mounting pairs orifice (9) / block (10). With reference to constrained allowances Chap. 8e) the problem of twofold tolerance zones is thereby raised in higher power! A very low impact force easily detaches the mounts from the orifice (9) and the block (10) due to the large clearance between the latter. The benefit from this "invention" is reduced to an absolute zero! Compare with countermeasures according to the Chap. N2 and N6.

9d 3th claim: Concerning the stiffness increase the mounting of the reinforced panel at the outer panel (la paroi extérieure) is completely useless due to the above-mentioned reasons

9e Notwithstanding the big expenditure of manufacturing and costs (Chap. N3) this invention as well as all the claims are absolutely useless in practice and tests! Notwithstanding the great R&D advances of more than two decades since the date of filing the car producer as patent proprietor should have manufactured the *world's safest cars* concerning collision protection. Instead two new models with truly beautiful design have failed absolutely at the independent tests carried out by Auto Motor und Sport, published in 24/93 issue and by ADAC published in 4/94 issue. Auto Motor und Sport classified the test result by verdict of "one of the two black sheep characterised by risk of fatal injuries". ADAC classified the test result by verdict of "71% reduction of the space for feet". This experimental verification shows an excellent agreement with the above-mentioned theses (9a-9d) and the failure of this "invention". See countermeasures according to the Chap. N.

9f See advantages of the new invention over this Patent Application in Chap. N3, N6, N7, N8 and N9.

10. Doubtful Invention of Chrysler Patent Application FR 22 57 449 of 07.01.75

10a Despite the assertion "les poutrelles" (19) (page2 / row13 and page 13 / row8) = "small beam" it is a reinforced element of shell or panel based on the drawing illustrated in Fig. 1, 2 and 3.

10b Due to the *lack* of recesses it is *impossible* either to assemble or to fasten the nuts (32). The accomplishment by drawing is logically different than in practise, hence, it is **doubtful** how to bolt the couplings (30, 40) together with the reinforced elements (19) of the adjacent doors and the coupling (35) together with the plate (36) of the B-post section. As further difference between *beam and shell or panel* a threading operation can be performed for panel but the threads as substitution for nuts (32) are *incapable* of absorbing the impact energy. Unquestionably, in order to enable one worker to assemble the couplings each door needs two recesses in the inner panel (18) and the reinforced panel (20) in proximity of the coupling. However, this operation is highly time consuming. Making recesses weakens the structural stiffness of reinforced panels with the result of overstressing those termini! Chap. A8 explains the embodiment of assembling under aspects of technically efficient and time saving operations.

10c Additionally to the above-mentioned case, there is the adjusting problem due to the multifold tolerance zones as Chap. 9c. After having successfully adjusted the functional locking for the front door in co-operation with the constrained allowance for a big tolerance between the block (29) and the recess (37) the assembler must face the adjusting problem between the back door lock and the reinforced element (19) while the back door is in misfit with the corresponding mount of the C-post section. To avoid the high manufacturing costs to meet the precise tolerances and to minimize the changes of the plate (36) the car producer applies to the method of the very large tolerance zones for the mounting pairs blocks (29) / recesses (37, 41) at the corresponding B- and C-post sections. A very low impact force enforces easily the state of being detached from the recesses (37, 41) because of the very big clearances. The benefit from this "invention" is reduced to an absolute zero! Compare with countermeasures according to the Chap. N2 and N6.

10d Notwithstanding the big expenditure of manufacturing and costs (Chap. N3) this invention as well as all the claims are absolutely useless in practice and tests! Notwithstanding the great R&D advances of 18 years since the date of filing the car producer as patent proprietor should have manufactured *very safe vans (7-8 passenger vehicles)* concerning collision protection. On the contrary this van failed absolutely at the independent test carried out by ADAC published in 4/94 issue. ADAC classified the test result by verdict of "collapse of the passenger cell". This experimental verification shows an excellent agreement with the above-mentioned theses (10a-10c) and the failure of this "invention". See countermeasures according to the Chap. N.

10e See advantages of the new invention over this Patent Application in Chap. N3, N6, N7, N8 and N9. The benefit from this invention in relation to expenditure of material, labour and cost is outlined in Chap. N3.

11. Doubtful Invention of Nissan Patent Application DE-OS 23 64 632 of 24.12.73

The integrity of the assumptions:

- page 1: "Because of the impact of the front collision the hinge couplings are destroyed, hence, the doors are detached "
- page 7 / row 17-20: "The stiff part is capable of preventing the door from moving outward as the hinge is broken"
- page 7 / row 24-28: "After the fracture of the hinges due to the front collision the opening of the doors is prevented by engaging the stiff parts (32) with the holes (36)"

and the integrity of the invention regarding the engaging effect between these parts of the front door with the A-post section present are further undermined by the test results published in the 11/93 ADAC issue. Having carried out a 40% Offset Crash Test of a 1900 kg heavy jeep of the patent proprietor against a rigid barrier ADAC compared the collapse of the passenger cell to that "of a house of cards" on page 24, notwithstanding the great R&D advances of 20 years since the date of filing. Nevertheless the totally deformed and open driver door was still coupled with the hinges. By no means could the engaging embodiment prevent the deformation of the passenger cell, even though the hinges were *unbroken*. This experimental verification shows the failure of this "invention".

No hinges were broken in any of the cars involved in front collisions as well as crash tests. Under the aforementioned assumption on fracture of well undersized hinges e.g. from an old-timer only a single load case of torsional moment M_y about the y-axis (Chap. 8c, Fig. 22) is going to deform totally the front door with the invented parts, whereas these parts remain undeformed.
In reality such *petite* (small) parts are unsuitable for being subjected to the load cases (Chap. 8a, 8b and 8c) due to the front collision!
It is compulsory at first to embody the four steps (Chap. N6) for stress reduction, then as 5. and 6. steps to incorporate the standard parts (5.6, 5.7, 5.6B, 5.7B) into clamping with the corresponding A- and B-post sections illustrated in Fig. 16. Despite the far higher stiffness in compound arrangement with the strong hinge frames, costs for manufacturing and assembling are far lower than the invented *petite* parts. These standard parts are laid out to meet those specified criteria in Chap. A7 by yielding practical advantages.

12. Invention with limited applicability of Daimler Benz Patent Application DE-OS 22 06 998 of 15.12.72

12a The hollow girder (7) comprises two outer panels welded together (11, 12) and a reinforced profile (13) placed in a cavity between these both panels shown in Fig. 1 or two panels (15, 16) being shaped to form a storing place, arm rest etc. shown in Fig. 2. The consequences (Chap. 8e) arise because the door locks can not withstand the load cases according to the Chap. 8a, 8b and 8c. Compare with countermeasures according to the Chap. N6. The benefit from this invention in relation to expenditure of material, labour and cost is outlined in Chap. N3.

12b See advantages of the new invention over this Patent Application in Chap. N3, N6, N7, N8 and N9.

13. Invention with limited applicability of Roltra Patent Application DE 37 18 767 A1 of 04.06.87

13a The frame (2) comprises two sections, upper (3) and lower (4). The rods (12,13) and the plates (14,15) are fixed to the lower section. Among all Patent Applications this invention is characterised by the highest moment of resistance and inertia. Unfortunately, the benefit thereby is reduced to an absolute zero, as expounded in Chap N3. Compare with the door truss in Chap N5.

13b In contrary to the above-mentioned the impact beams of the new invention utilize the *whole* door thickness owing to the new designs for resolving the problem of the window guides (Chap. A3). On the basic comparison regarding the bending and torsional stiffness with Roltra rods (12,13) the impact beams are much greater than these rods with the U-shape and smaller width. Regardless of the higher manufacturing, assembling costs due to the precise adjustment and regardless of higher material costs, more weight due to more parts the total structural stiffness of Roltra invention is definitely much lower than the fourfold step of increasing the structural stiffness (Chap. N6).

13c Referring to page 1 / row 5-18 the outer and inner panels (31,36) are suitably fixed to the lower section (4) shown in Fig. 1, *not* to the rods due to the interference by window guides and pane. Owing to the new designs for window guides the panels are secured or fixed *directly* to the impact beams, if necessary, additionally to the reinforced elements. This embodiment and the practical advantages are depicted in Chap. A8.

13d With reference to Fig. 2 the method of standardisation is impractible because of the following assembling specifications (page 3 / row 23-35): fix up the U-shape of the rods (12,13) in inward direction, fix the back surfaces of the rods to the inner surfaces of the columns (10,11), fix two plates (14,15) to the U-edges of the rods, assemble together with the frame into a door unit. By contraries the impact beams as door truss are solely responsible for themselves. Regardless of whether the surfaces are fixed backwards, upwards or sidewards, the lay out is depending on design criteria. Thus, far higher structural stiffness by fewer parts is the benefit of the new invention.

13e See advantages of the new invention over this Patent Application in Chap. N3, N6, N7, N8 and N9.

14. Dow Chemical Patent Application of EP 02 60 767 A2 of 18.09.87 with the following proposals:

- Door assembly by inserting a cartridge into the cavity between the outer and inner panels from *front* to back (in y-direction illustrated in all Fig.). It is suitable for window panes of *small height.*

The only way of assembling is to telescope the door shell (column 10 / row 1-3) through the access opening (12) over the cartridge (14) with a *small high* window pane in y-direction. Assembling opposite to the y-direction way is impossible because the other access (13) is smaller than the flange (19). The door assembly of the new invention is performed by inserting through the access opening of *lower* side of door shell in z-direction. It offers two assembling approaches from the bottom and from the top as described in Chap. A8a. The following benefits of the new invention over this Patent Application are:

- Means of adapting as practical advantage (Chap. A8). With regard to (column 5 / row 50-58), (column 6 / row 1-8) it is infeasible for this reason: Through the access opening (12) the cartridge assembly (14) is inserted by aligning the support member with the guide members (20) of the door cavity (11) until engaging the flange (19) with the enlarged portion (17). It can always happen that the outer panels of the adjacent doors will not fit to each other in conjunction with the chassis regarding the appearance, e.g. height differences in z-direction and gap differences in y-direction. Material, labour intensive and time consuming operations are costly for replacing the doors.
- Locating a high-size window pane protruding above the lower window frame in the door truss saves at least one work cycle. This advantage is outlined in Chap. A8 and A8a.

15. Doubtful Invention of AUDI Patent Application DE-OS 3934590A1 of 17.04.89

The reinforced element as (24) in Fig. 1 comprising one inner shell (7) and two side impact girders (35) can be replaced by one impact beam with bigger stiffness but it is far cheaper to be manufactured.
Regardless of increasing the bending stiffness thereby the door will be totally deformed by the energy of side collision and the rest energy deforms the occupants. Due to lack of crumpling zone the state of deformation of the door is far bigger than at the front collision. Generally, such stiffness increase is unsatisfactory. Given as hypothesis, it were satisfactory, the door lock can not withstand the following loading as Z_T and H_B illustrated in Fig. 1, as well as, the door edges the following loading as Z_D and Z_S. Furthermore, the examples in Chap. N3, Fig. 23 and 24 substantiate the doubtfulness of this "invention". Beyond the useful embodiment (Chap. N3), suitable formulae of solutions will be taken into account in Chap. A7.

N. New Invention

N1 Boundary condition as countermeasure against coming loose from the mount. With the exception of Jaguar EP 0472284 (*tensile/compressive and torsional loads)* the boundary condition "free supported cantilever" of all Patent Applications permits only *tensile/compressive forces.* In association with this boundary condition the deformational behaviour of all invented reinforced elements is similar to the structural element "*rod*" despite the various types of structural elements.
An individually deformational behaviour in association with the load cases for a specific beam is determined by adopting precisely the boundary condition:
- Beam under *shear-forces, bending moments*
- Beam under *shear-forces, bending moments and torsional moment*
- *Beam-rod under tensile/compressive-, shear-forces, bending moments and torsional moment by adopting the boundary condition of "rigid seat" or "being pinned (fixed)".* This beam-rod is employed in the new invention.

Logically, the basic equations of the strain-displacement relationship for those beams differ from each other. Readers unfamiliar with these equations are referred to the books of FEM and Technical Mechanics. Particularly, the practical application shows the disparate use of the structural elements as shell, not beam for chassis and in Chap. 10b "further difference between *beam and shell or panel".*
As **new Inventions** are the following proposals:
1. Use of *Beam-rod* as impact beam,
2. Adopting *the corresponding boundary condition,*
3. Mounting the door hinge frames according to S1 configuration (Chap. A2),
4. New designs for installing the window guides and pane by utilising the *whole* door thickness (Chap. A3),
5. Retaining blocks (Chap. N2),
6. Retaining hooks (Chap. N2),
7. Standard parts as retaining blocks (Chap. A7),
8. Retaining blocks with lock function (Chap. A5a),
9. Door truss (Chap. N5),
10. Adopting the compound construction for integrating the car parts into whole car side (Chap. N5),
11. Adopting the compound construction for integrating both car sides via the roof and the vehicle floor (Chap. N5),
12. Method of assembling (Chap. A8),
13. Standardising Method of minimizing the number of the beam types for doors of different car classes (Chap. A15).

While the similar proposals were mentioned in the other Patent Applications the following better proposals with significant advantages are classified as **relative new Inventions**:
14. Impact springs (Chap. N10),
15. Two modular door assembly Concepts (Chap. N11, A8a, A8b).

N2 Retaining blocks (Chap. A4), retaining hooks (Chap. A7) and retaining blocks with lock function (Chap. A5a)

N3 Beyond doubt the total structural stiffness of Roltra Patent Application DE 3718767 A1 among all Patent Applications with the exception of the New Invention is the biggest. Nevertheless, this improved stiffness is impracticable because of the aforementioned boundary condition, the mount is going to come loose just after the loading. In contrary to the single impact beam owing to that specific boundary condition (Chap. N1) this does not occur at all! At incremental energy to the limit of structural fatigue failure this single impact beam affords protection to the occupants. Far beyond imagination are the labourious inventions to reinforce *solely* the element body (FR 2207039, FR 2257449, DE 1755661B2, DE 34257777, DE-OS2206998, DE 3718767 , DE 2836213, EP 0479401, DE 3934590), whereby termini (element ends) as well as conventional door locks are *non-reinforced*, hence, *weak* concerning the moment of resistance and inertia. Not the reinforced element body, but on the contrary, those undersized termini and locks undergoing overstress fracture *at first*, if the mounts have not yet detached due to large clearances.
Such a so-called "reinforcing" method can be regarded as

"erroneous view of R&D engineering since more than two decades".

In analogy, the increasing corpulence as "reinforcing method" is *no prescription* against fragile feet at slippery surfaces ("free supported cantilever" and undersized terminus) and against the weak neck (undersized terminus)! The benefit from those "inventions" is reduced to an **"absolute zero"**! The most efficient way is to resolve the basic difficulties concerning that aforementioned boundary condition "free supported cantilever", with the solutions in Chap. N1 and N2, and concerning the overstress of those termini", with the solutions in Chap. A1, N4, N5 and N6. Design criteria must specify the complementary requirements (Chap. A5a) to ensure against the structural fatigue failure of mounts and against self-opening in the event of collision and/or overturn (Chap. U2) as well as to satisfy the boundary condition.

N4 Beam-rod as impact beam (Chap. A1). In comparison with other structural elements (rod, panel or sheet, plate, shell) of all Patent Applications beam after solid element shows the *biggest* moment of resistance and inertia. For structural strengthening the door shell a door girder placed in the cavity is rigidly attached to both panels. Consequently, there are little space left for reinforced elements. They are structurally undersized! Reinforced elements of all previous Patent Applications as rods, plates, girders and the side impact supporter may be termed generally as impact rods. As bi-functioning part impact beam with arbitrarily big cross section replaces the impact rods and the door girder by assuming both functions with the advantage of gaining space (Chap. A11). Furthermore, taking the advantages of this space other parts as reinforced elements etc. can be accommodated.

N5 Door truss (Steiner's principle in the following Chap. N6) and 1st embodiment of compound construction.
The overlapping reinforced elements (Chap. 9c) with two orifices are characterised by the inabilties to retain and to clamp. On the contrary, owing to the abilities the adjacent door trusses are in compound construction with all corresponding post sections, hence, the structural stiffness of whole car side is increased significantly. This "whole car side" (Fig. 22, definition in Chap. A6) is capable of resisting far higher total loading according to the stress calculation in Chap. 8d. The definitions of "door truss and compound construction" as well as of "clamping" will be formulated in Chap. A6.
The 2nd embodiment of compound construction deals with the interconnecting of both car sides, the roof and the vehicle floor via the corresponding clamping means as depicted in Chap. A7.

N6 The four steps of increasing the structural stiffness is abridged in explanatory sequence:

- 2nd *biggest* moment of resistance and inertia among structural elements is the property of impact beam by consideration of that boundary condition regarding Chap. N1 and N2.
- Door truss Concept is benefited by *improving* the already increased stiffness associated with Steiner's principle for calculating the moment of inertia about the axis aa as $I_{aa} = I_p + F*e^2$. In comparison with all Patent Applications this stiffness is much bigger, but the manufacturing costs are far lower.
- 1st compound construction Concept: By adopting the principle constructive improvements (Chap. A6, Fig. 2, 3, 4, 15 and 16) the structural stiffness of each whole car side is heightened significantly.
- 2nd compound construction Concept: By adopting other principle constructive improvements (Chap. A7, Fig. 1 and 23) to interconnect both car sides and other car parts the total structural stiffness is increased substantially and reaches the maximum of stiffness. Overstress is avoided by stress distribution, as applied to bridge and building construction.
- Stress and deflection of all parts as retaining blocks, hooks etc. are substantially lower than all Patent Applications. By embodying those four steps termed under "Principle of load distribution" in Chap A6 this total structural stiffness meets the requirement specified in Chap U3:

"Reducing the three dimensional displacements, in x-, y- and z-direction in all Figs., to increase the chance of survival"

N7 In comparison with all Patent Applications the manufacturing costs are much lower thanks to the construction by use of standard parts as standard beams, standard couplings for screws, nuts etc.

N8 In order to resolve the problems (Chap. 8e, 9c, 10c etc.) of several tolerance zones, adjusting and exchanging constructive measures are developed for the concept of single adjusting (Chap. A13) in enabling to determine exactly the tolerance zone (Chap. A14). Owing to the method of assembling and adjusting from outside of the car body the labour intensive and time consuming operations are reduced immensely.

N9 The energy of side collision is absorbed by the aforementioned *total structure* in compound construction (Chap. A9). In comparison with all Patent Applications this construction provides a *threefold* function of protection for occupants on front collision as well as side collision and as well as rear collision. Cost saving is achieved enormously, particularly, by a *single* operation of constructing, manufacturing, testing, assembling associated with a single material supply.

N10 Impact beams (impact springs) as soft crumpling zone for absorbing the impact energy is depicted in Chap. A9.

N11 Modular door assembly concepts with improving proposals over the two Patent Applications illustrated in Chap. 13c and 14 is depicted in Chap. A8a and A8b.

A1 Impact beam

Concerning the property of impact beam the moment of resistance and inertia for both termini without orifices are as big as for the body itself. If stress reinforcement is necessary the structural modification on orifices is conducted by welding a reinforced plate (1.1a and/or 1.1b shown in Fig. 8) to the surface of the terminus side before machining an orifice through this side, or tandem orifices through all sides. Costs for such operations of modifying are very trifling, particurlarly, in comparison with the wrong, far more expensive approaches of those "inventions" referred as "reinforcing" method in Chap. N3.

Fig. 23 shows a reinforced plate attached rigidly to the reinforced panel by welding.

In association with the rigid boundary condition (Chap. N1) the comparison of this basic concept with all Patent Applications shows the advantages of saving cost, material as well as of increasing *constantly* structural stiffness (Chap. N4) along the y-axis.

With respect to Technical Mechanics and FEM beam elements or impact beams are classified into:

- closed cross sectional configurations as P20, P21, P27, P28 shown in Fig. 7.
- open cross sectional configurations as P22 to P26, P29 to P35 shown in Fig. 7 and as P1 to P9 shown in Fig. 6. To the recesses of these beams the window guides for guiding window pane are attached rigidly. By punching out or burning operations any beam with closed cross sectional configuration can be machined into an open configuration for the recesses of window pane. See Chap. A3.

By welding or gluing operations or screw couplings several beams can be nested into an united beam as M3 and M4 illustrated in Fig. 21

Depending on the possibility to rigidly attach window guides and structural elements of window guides (Chap. A3) decision for open or closed cross sectional configuration is made.

A2 Impact beam with door hinge frame

By welding or gluing operations or screw couplings (5.2B and 5.4B illustrated in Fig. 3) the strong door hinge frame (5.2 and 5.2B illustrated in Fig. 2 and 16) is attached rigidly to the front side of terminus (S1 configuration illustrated in all Fig.). This *new proposal,* not yet invented in any Patent Application, has the following advantages:

1. All tolerances for beam length, thickness of door hinge frame and for positioning the retaining orifice are referred simply and solely to the same y-axis. Hence, it is easier to meet the permissible allowances.
2. The loads of torsional moment about the y-axis and bending moments along the y-axis are absorbed thereby definitely better than by configuration of S2, S3, S4 or S5 shown in Fig. 8.
3. In co-operation with the clamping means of standard parts (5.6 and 5.7B in Fig. 16) on collision the face to face configuration of both hinge frames affords stress reduction for hinge bolts (5.5 and 5.5B in Fig. 16). See Chap. A7.

The rotating axis of the door hinge (5.1, 5.1B) with S1 configuration is determined by the equation $t \leq c \leq (b-t)$, whereas the symbols t, c and b are denoted in Fig. 8.

Assembling by screw couplings (5.2B with 5.4B shown in Fig. 3) is disclosed in Chap A8.

A3 Window pane, window guides, structural elements of window guides and window gear

Given t for the whole door thickness, stress reduction and stiffness increase are depending on t^2 and t^3 by consideration of moment of resistance and inertia. With regard to lack of crumpling zone at side structural configuration this factor of t plays a more determining role on stress reduction than at front structural configuration.
In order to exploit the whole door thickness for beam width, constructive improvements are developed. These *new proposals* are not yet invented in any Patent Application.

Being attached rigidly to the respective beams by welding or gluing operations or screw couplings the window guides (6.1, 6.2, 6.1B and 6.2B shown in Fig. 3) guides the window pane (6):

- through the recesses on the impact beams (1 and 7 shown in Fig. 2) or
- at the impact beams (1 and 7 shown in Fig. 4) or
- between the impact beams (P2 and P3 shown in Fig. 6).

Suitable for window guides are:

- panel as common material or
- structural element as beam with U-shape illustrated in Fig. 22 or
- new lay out, whereas the structural elements (6.1a, 6.2a, 6.1aB, 6.2aB illustrated in Fig. 1 and 23) of window guides (6.1, 6.2, 6.1B, 6.2B) are attached rigidly to the respective impact beams as described in Chap. A7.

The window gear (7.1) is mounted to one of the door trusses (8.3, 8.4, 8.30, 8.40 shown in Fig. 18 and 19). See definition of "door truss" in Chap. A6 and thereto Chap. A8c.

A4 Impact beam with retaining function

In order to ensure against the structural fatigue failure of mounts with respect to 3rd requirement in Chap. A5a, a strong door hinge frame (5.2 and 5.2B illustrated in Fig. 2) is rigidly attached to the terminus (beam end), whereas the other terminus is designated for:

- tandem retaining orifices (Fig. 3, 12 and 23) machined at both sides of a beam or at all sides of united beam (Chap. A1). By definition tandem retaining orifices denote the configuration of orifices being positioned one behind the other. Comparing with the above-mentioned proposals for several orifices (Chap. 9) this embodiment attributes the advantageous machining to reference of all tolerance zones, solely, to *one* axis.
- or a single retaining orifice (Q1, Q2, Q3 and Q4 shown in Fig. 8), e.g. the elliptical hole (Fig. 3).

Q1, Q2, Q3 and Q4 configurations are corresponding to the closed planes of circle, ellipse, rectangle and trapezoid.

During the locking operation the above-mentioned beam telescopes over the retaining block (2.1a illustrated in Fig. 3, 2.1A for tailgate door illustrated in Fig. 1) without contact between its orifices and the corresponding block. See 1st requirement for retaining condition in Chap. A5a.

For variational construction with respect to 4th requirement in Chap. A5a the cheapest and easiest proposals as H1, H2, H3, and H4 shown in Fig. 17 are suitable. All proposals comprise standard parts with exception of the silencing stop ring (2.11). The variational construction with the proposal H1 consists of a hexagon socket head screw (2.10) ref. to DIN 912, a big washer (2.13) ref. to DIN 9021, a silencing stop ring (2.11) and a number of washers ref. to DIN 125 as spacer (2.12) responsible for the clearances (S3 and S4 shown in Fig. 12). See Chap. A14. Those clearances are determining for the clamping condition in reference to the definition outlined in Chap. A6 on front and/or side and/or rear collision.

The following parameters for meeting the clearances with respect to 1st requirement in Chap. A5a are:

- size-changing the outer diameter of washer (2.13) denoted as d
- and/or correcting the length of spacer (2.12) denoted as l by removing or adding several washers.

Based on those variational constructions other lay outs by use of standard screw couplings can be designed as H4 with spacer (2.12), nut and washer (2.13).

Structural elements with retaining function, retaining blocks and hooks illustrated in Fig. 1, 23 and 24 are depicted in Chap A7.

A5a Impact beam with retaining and locking functions

The above-mentioned fatal accident in Chap. U2 and Crash Tests in Chap. 8e, 9e, 10d, 11 have proved the *failures* of all conventional door locks and mounts termed as *structurally weak members*. Regardless of whatever embodying to achieve increased structural stiffness those *members* are in structural fatigue failures and/or detached (Chap. U2, N3).

In order to ensure against structural fatigue failures and self-detaching, the following complementary "requirements" as design criteria are to be defined:

1. In the event of collision and/or overturn retaining blocks are capable of fulfilling the "retaining condition", *primarily*, in association with the locking condition. Under load cases of Chap. 8a, 8b, 8c (Fig. 22) as well as Chap. A7 (Fig. 23, 24) those characterised blocks are deflected *briefly* in order to ensure the clamping condition between all mating mounting pairs as blocks / orifices, blocks / holes and hooks / reinforced rod (Fig. 24). Regarding tolerances for mounting pairs the tolerance zones (Chap. A14) for blocks or hooks with retaining function may be chosen bigger than those for blocks with retaining and locking functions.
2. Because the conventional door locks can not withstand loading, new door locks are designed in conjunction with blocks as *load girder*.
3. In order to ensure against the state of being detached easily from the mounts referred in Chap. 8e, 9c (four mounting pairs) and 10c, only a single mounting pair with its tolerance zone may be incorporated into each impact beam.
4. By consideration of cost and time saving all operations related to adjusting, positioning and assembling for above-mentioned mounting pairs may be performed, principally, from outside of the car body in order to meet two conditions of clamping on collision and of functional locking.
5. Change the position of the locking block-axis from y-direction to x-direction or to nearby x-direction, in the range of angle $\leq 30^0$, the exception of the retaining block (15.1) at the A-post section to absorb the impact energy on front collision (Chap. 8) and/or on side collision (Chap. A9, Fig.1 and 23).
6. Subjected to dynamic loading by collision and/or overturn the locking plate (3.1) with the mass m is energised by the kinetic energy of $m*v^2/2$. This resulting force (energy) is responsible for the self-detaching of locks and mounts. As reported previously the doors of the totally deformed car opened and closed alternatively during the overturn. Consequently, the requirement of "interlocking condition" in the state of locking may be brought about by a need for preventing such adverse effects and for ensuring safety of occupants.

Analogous to the proposal in Chap. A4 is the embodiment of rigidly attaching the door hinge frame to the terminus, whereas the other terminus is designated for orifice.

In order to meet the 1st and 2nd requirements the locking plates (3.1 or 3.8 shown in Fig. 11) being guided in y-axis are placed behind or in front of the retaining orifice. At locking operation the outer (3.8) or inner (3.1) edge of locking plate or the edge of locking pin (3.9) glides along the corresponding contour of locking, guiding, retaining block (2.1) without contact between block and retaining orifice.

Descriptions about gliding variation and operations of gliding and locking are found in Chap. A12; about tolerances in Chap. A14.
The movement of locking plate in y-axis is governed by

- guiding pins (1.2 and 1.3) corresponding to F1 or F2, as illustrated in Fig. 10
- or being in light contact with the sides of U-shaped locking plate (1), whereby as bi-functioning part the pin (1.2) is designated for retaining and positioning the plate, as illustrated in Fig. 11.

With respect to 1st, 2nd, 3th and 4th requirements small tolerance zone may be met by the following constructive means:

- by selecting other adjusting ring (2.3) designated for adjusting described in Chap. A13. Characterised by various parameters and shapes the rings are illustrated in Fig. 14 as M1 to M3, M1a to M3a, ML1 to ML3 and ML1a to ML3a. For purpose of inserting a rod as tool to adjust clearances from outside of the car body small holes are provided on the rim of ring.
- and/or by selecting other retaining block (2.1, 2.1B) with locking function and gliding property. 21 blocks are configured in Fig. 9 as K1 to K7, K1a to K7a, K1b to K7b. For hull of block are suitable cylinder section, truncated cone (Fig. 13), spherical section, hyperbolical section of one sheet, elliptically parabolical section, whereby the number of various blocks increases, greater than 21 illustrated in Fig. 9. For purpose of operating from outside of the car body hexagon socket head is provided on the front side or head of block, just as hexagon socket head screw ref. to DIN 912.
- and/or by selecting other retaining orifice (Q1, Q2, Q3 and Q4 shown in Fig. 8).

With respect to 6th requirement of "interlocking condition" the door locking mechanism latches itself on the state of locking in order to secure against the movement of locking plate energised by kinetic energy as follows:

- by blocking means (D1 shown in Fig. 11), whereby the plate (3.2) is projected in the groove (3.3) of impact beam
- or by blocking (D2) together the groove (3.4) of locking piece (3.1) with the corresponding groove of impact beam
- or by blocking (D4) together the hole (3.5) of locking piece (3.1) with the corresponding hole of impact beam
- or by blocking (D3) the cut-out (3.6) with the corresponding guiding pin (1.2) of impact beam whereas this pin is engaged in the cut-out upon pulling up the locking piece (3.1).

By activating the locking mechanism to open door this interlocking condition is released immediately.

The aforementioned proposals are concerned with interlocking property in association with retaining blocks with locking function and gliding property, while the following in association with retaining blocks only concerned with locking function as illustrated in Fig. 20.

The following constructions of latching are in effect by blocking:
- on moving the pin (2.30 shown in Fig. 20) guided by two silencing bushings (2.31) from its position "O" (Open) into "L" (Lock). This pin is secured by two retaining washers for shaft (2.32) ref. to DIN6799. To shorten the assembling time all parts are assembled into one unit mounted (2.33), then screw coupled with silencing intermediate layer (2.34) to the impact beam (1, 1B).
- or on rotating the silencing plate (2.16) guided about the axis of bolt (2.19) from its position "O" into "L". This plate with silencing intermediate layer (2.17) is secured by the nut with thread security (2.18) or by double nuts to prevent from coming loose.

Both constructions, similar to H1, are supplemented with the silencing rings (2.14 and 2.15). With the exception of these rings, notably, only standard parts are in use. Characterised by low-cost expenditure, but in some measure imprecise, these constructions are suitable for:
- car doors of economic class, slide doors, tailgate doors (2.1C shown in Fig. 1) in compliance with 1st and 2nd requirements.
- self-latching in z-direction being activated by the door locking mechanism while the locking plate (3.1) moves in y-direction. On overturn, force being active in z-direction, the state of locking is non-deferred. On front or rear collision, force being active in y-direction, the state of locking is deferred, but on contrary, the state of latching non-deferred.
- self-latching being activated by the door locking mechanism in the same y-direction as opening direction of the locking plate (3.1).

Alternatively thereby, one of these both states is always in charge of interlocking on collision and/or overturn in compliance with 6th requirement. By activating the locking mechanism to open door this interlocking condition is released immediately.

As additional security against burglary as well as vehicle theft the way of accommodating the locking plate with or without gliding property *behind* impact beam makes it difficult to break into from outside of door.

A5b Impact beam with retaining function in conjunction with conventional door lock

The same construction as in Chap. A4 is supplemented with a conventional door lock (9) consisting of the locking wheel and catch block (9.1 shown in Fig. 3). Operation of door assembly corresponds to the concepts in Chap. A8a and A8b. To some extent, this application could be limited due to the failure referred to in Chap. U2 and N3. In case of limited application a functional test should clarify whether the clamping condition is ensured between a long screw and the tandem retaining orifices (Fig. 3, 12 and 23) on collision.

A6 Door truss and compound construction on side and/or rear and/or front collision

By means of strong door hinge frames the A-post section and the front door truss are interconnected.

By definition a "door truss" (8.3, 8.4, 8.30, 8.40 shown in Fig. 18 and 19) as door girder (Chap. N4) is an assembly comprising one or several impact beams with window guides (6.1, 6.2, 6.1B, 6.2B) or with structural elements (6.1a, 6.2a, 6.1aB, 6.2aB illustrated in Fig. 1 and 23) of window guides and with other door parts. Thanks to space gain (Chap. A11) reinforced elements (10.1, 10.2, 10.1B, 10.2B) as supplements can be assembled in as illustrated in Fig. 1.

By definition of "compound construction" the adjacent door trusses and all post sections are interconnected by clamping means of the beams in the corresponding retaining plates (4 shown in Fig. 4) of door hinge frames (5.1B) as well as by clamping means of the beams in the corresponding retaining plates (4B shown in Fig. 4) in the event of closing door. Structural car parts being clamped at one side are termed as " whole car side" being referred in Chap. U4, N5, N6. Details are drawn in Fig. 16. See assembling in Chap. A8. In case of 2-door vehicle (Fig. 3, 15) the front door and all post sections are interconnected by clamping means of the beams in the corresponding retaining plates (4) welded to the front sides of impact beams (7B shown in Fig.3, 1B) in the event of closing door. Details are drawn in Fig. 15.

Concerning the fourfold step of increasing the embodiments of compound construction in association with door trusses, all post sections as well as with both car sides, roof and vehicle floor (Chap. A7) achieve an enormously increased structural stiffness, incredibly far bigger than the invention from all present Patent Applications. The ultimate objectives to reduce stress, strain and displacement are met thereby, as explained by the following arguments:

- Subjected to side impact energy impact beams are displaced in x-direction. Therefore, the state of "clamping" occurs between the retaining block (2.1a shown in Fig. 17), the locking, guiding, retaining block (2.1 shown in Fig. 15 and 16) and the corresponding retaining orifices and/or between the retaining hooks (Fig. 24) and the reinforced rod. The displacements of impact beams being subjected to front and/or rear impact energy cause, similarly, the state of "clamping".

- The present boundary condition "free supported cantilever" is changed into "rigid seat" or "being pinned" by employing the state of clamping. Owing to this rigid boundary condition material of structural element can be maximally exploited. Impact beam as structural element is under load of tensile/compressive-, shear-forces, bending moments and torsional moment.

- By definition of bi-functioning part the door truss replacing door girder takes over additionally the function of girder and assumes the prime function of reinforcing to ensure against impact energy, similar to reinforced elements of all present Patent Applications. By substituting both parts space is gained wherein the exploitation is described in Chap. A11.

- Front impact energy is absorbed by the whole car sides of 4- as well as 2-door vehicles.

- In order to avoid torsional deforming at tailgate door (Chap. U4) or slide door the embodiment of the state of clamping is employed by means of retaining blocks (2.1A, 2.1C shown in Fig. 1) and by use of new door locks according to Chap. A5a for ensuring safety of occupants, on other hand, structural stiffness is increased. The danger for occupants being hurled through the totally deformed tailgate door (see report of car accident) is thereby eliminated.

- The embodiment of "Principle of load distribution" by means of those threefold steps of increasing structural stiffness and of the fourth illustrated in Chap. A7 leads to a high number of multi-supports and supporting forces. As far as the single force H_6 at the B-post section illustrated in Fig. 1 is concerned this apparently single force on one support represents exactly four supporting forces arisen by clamping of the retaining blocks (15.3, 15.5 shown in Fig. 1 , 23 and 2.1, 2.1a shown in Fig. 2) in the corresponding parts. Logically, the number of multi-supports and supporting forces H_i is greater then 10. Owing to this "Principle of load distribution" on multi-supports loads are substantially much lower, with the following structural benefits:
  - Overstress and collapse of A-post section, front passenger cell are avoided on normal collision and overturn. To great extent, the survival depends on the magnitude of impact energy e.g. from the collision between a 10 tons heavy truck and a light-weight car at impact speed of 100 km/h.
  - Stress and deflection of all parts as retaining blocks, hooks etc. are substantially much lower than all Patent Applications.
  - The state of detaching from mounts can be generally avoided due to lowering considerably the loads

- Conclusive evidence may be derived from the theory of structural engineering that those complementary requirements (Chap. U1, U2, U3 and U6) regarding side and/or rear and/or front collision front can be met to a great extent by embodying the New Invention.

A7 Compound construction with roof and vehicle floor by means of retaining blocks, retaining hooks and standard parts

As complementary measure to the 1st embodiment of above-mentioned compound construction the 2nd embodiment of compound construction of both car sides with roof and vehicle floor by clamping means aims:

- to enhance substantially the already increased structural stiffness and
- particularly, to reduce considerably displacements in z-direction on overturn as well as in x-direction on side collision (Chap. A9) as well as in y-direction on front and/or rear collision.

On overturn and collision those clamping means lead to the state of clamping
- between the retaining blocks (15.1 to 15.5a) and the corresponding reinforced panels (17.1, 17.1a, 17.1b, 17.1c, 17.2, 17.2a, 17.2b, 17.2c, 17.2d, 18.1, 18.1a, 18.1b) illustrated in Fig. 1 and 23
- and/or between the retaining hooks (15.6) and the reinforced rod (17.1d) illustrated in Fig. 24.

The principle of constructive countermeasures is based on the load case found in Chap. 8 and Fig. 22 concerning front collision, valid for rear collision by mirroring the impact force F in Fig. 22 applied to rear (trunk), and valid for side collision illustrated in Fig. 1. Constructive countermeasures resulting from the various reinforced panels and retaining parts as mounting are outlined as follows:
Upon deforming on overturn and collision the following clamping means lead to the state of clamping:
- Standard parts (5.6, 5.7, 5.6B, 5.7B), whereas only the parts (5.6, 5.7B) associated with the respective impact beams are drawn in Fig. 16. In order to minimize displacement in z-direction all these standard parts in co-operation with the retaining blocks (15.1 to 15.5a) and retaining hocks (15.6) serve primarily to sustain the load case in z-y plane illustrated in Fig. 1 and 12. Furthermore, stress of door hinge bolts (5.5 and 5.5B) is lowered due to the structural involvement of those retaining parts in clamping condition with the corresponding hinge frames. For cost saving the use of the same standard parts for car is recommended, as round head rivets (5.6) ref. DIN660, adapter sleeves for heavy duty (5.7B) ref. DIN1481, pins, bolts or screws.
- Retaining block (15.1) screwed into the reinforced plate of L-shape of A-post section is in clamping condition with the oblong hole as retaining orifice of structural element (6.1a). This A-post section, the reinforced panel (17.1c) being bounded along the roof and transverse girder (17.2d) of both A-post sections are welded together. This construction is applicable too for the structural element (6.2aB) in association with the C-post section.
- Retaining block (15.2a) screwed into the block (6.11) of structural element (6.1a) is in clamping condition with the oblong hole as retaining orifice of reinforced panel (17.1) being bounded along the roof. This panel, the reinforced plate (17.2a), L-shape of A-post section and transverse girders (17.2, 17.2b) of both A-post sections are welded together. Cost saving can be achieved by adopting the reinforced plate (17.2a) just for transverse girder in replacing both girders (17.2, 17.2b). This construction is applicable too for the structural element (6.2aB) in association with the C-post section.
- Retaining block (15.2) screwed into the structural element (6.2a) is in clamping condition with the retaining orifice of reinforced panel (17.1a) being bounded along the roof. This construction is applicable for clamping of the retaining block (15.2) of structural element (6.2aB) in the corresponding retaining orifice.
- Retaining blocks (15.3, 15.3a) screwed into the corresponding sides of U-shape block (17.3) are in clamping condition with the corresponding oblong holes as retaining orifices of structural elements (6.2a, 6.1aB). As connecting element between both B-post sections and the roof this U-shape block at the B-post section, the reinforced plate (17.1b) being bounded along the roof and transverse girder (17.2c) of both B-post sections are welded together.

- Retaining block (15.4) screwed into the reinforced plate of reinforced panel (18.1) being bounded along the vehicle floor is in clamping condition with the retaining orifice of structural elements (6.1a). This construction is applicable too for the structural elements (6.2a, 6.1aB, 6.2aB).
- Retaining block (15.4a) from rivets e.g. round head rivet ref. DIN660 attached rigidly to the reinforced plate of reinforced panel (18.1a) being bounded along the vehicle floor is in clamping condition with the retaining orifice of structural elements (6.2a).
- Retaining blocks (15.5, 15.5a) screwed into the corresponding sides of U-shape block (18.3) are in clamping condition with the corresponding oblong holes as retaining orifices of structural elements (6.2a, 6.1aB). As connecting element between both B-post sections and the roof this U-shape block at the B-post section, the reinforced plate (18.1b) being bounded along the vehicle floor and transverse girder (18.2) of both B-post sections are welded together. To the U-shape block (18.3) the case of seat belt (26) is attached rigidly.
- Retaining hooks (15.6) screwed into the structural elements (6.1a, 6.2a, 6.1aB, 6.2aB) are in clamping condition with the reinforced rod (17.1d), as illustrated in Fig. 24. This rod and the transverse girders (17.2e, 17.2f, 17.2g) of both A-, B-, C-post sections are welded together.

By applying the associative rule to both mounting members, the placement of retaining block or retaining orifice to the structural element as well as to the reinforced panel as well as to the U-shape block is in either way presents no problem.
For the sake of illustration the reinforced elements (1a, 7a, 10.1, 10.2, 1aB, 7aB, 10.1B, 10.2B shown in Fig. 1) and the impact springs (P11, P13) are not drawn in Fig. 23.
Reinforced plate attached rigidly to the reinforced panel by welding extends beyond the retaining orifice as well as retaining hole. The other purpose of this plate is for screw coupling of the retaining block. Replace reinforced panel by beam or beam-rod, if weight does not play a great role, e.g. for truck.

Fig. 19 is a view of a door truss in co-operation with the retaining blocks (15.2a, 15.3, 15.4) in the state of door assembling (Chap. A8).

Each retaining block (15.1 to 15.5a) with the exception of (15.4a) comprises a screw (15.14), a bushing (15.11), a number of washers built into one spacer (15.12) and a washer with a large outer diameter (15.23), as illustrated in Fig. 23.
In order to ensure the state of clamping between retaining block / orifice and between retaining block / hole it is necessary to meet the 4th requirement (Chap. A5a) by preserving a small tolerance zone. Size-changing for the outer diameter d and/or the length of spacer l is provided on adaptation by:

- choosing a bushing with another outer diameter
- and/or correcting the length of spacer by removing or adding several washers.

Symbols l and d are denoted in Fig. 23.

As illustrated in Fig. 24 each retaining hook (15.6) comprises a hook (15.20) with inner diameter d_1 and gap s_1 smaller than d_1, a screw (15.21), a number of washers built into one spacer (15.22), a coil spring washer (15.24) and a nut (15.25). In order to ensure the state of clamping between the retaining hooks and the reinforced rod (17.1d) with outer diameter d_2 smaller than s_1 it is necessary to meet the 4th requirement by preserving a small tolerance zone. Size-changing for the gap s_1 and/or the length of spacer l is provided on adaptation by:

- choosing a retaining hook with another gap
- and/or correcting the length of spacer by removing or adding several washers.

For cost saving the use of standard parts is recommended, as washers ref. to DIN 125, screw (2.10) ref. to DIN 912 etc.

As far as the retaining block (15.4a) is concerned this rivet e.g. round head rivet ref. DIN660 is suited for low-cost construction subjected to low stress due to a large tolerance zone, hence, in practice in conjunction with the other retaining blocks (15.1 to 15.4). Each one of these blocks is appropriate too for substituting the block (15.4a) upon the specification for small tolerance zone.

Descriptions about tolerance zones between retaining blocks and retaining orifices as well as holes and about structural elements (6.1a, 6.2a, 6.1aB and 6.2aB) in conjunction with window guides are found in Chap. A9 and A14, respectively.

A8 Method of assembling

With respect to 4th requirement in Chap. A5a, operations of assembling back door trusses or back doors for 4-door car are performed as follows:

- Screw coupling *from outside* of the car body. By means of this embodiment the door hinge frames (5.2B) can be rigidly attached to the plates (5.4B) welded to the front sides of impact beams (1B, 7B), as illustrated in Fig. 3. This approach is applicable too for rigidly attaching to the plates welded to the front sides of impact beams (1, 7) of front door.
- or screw coupling *from inside* of the car body. By means of this embodiment the door hinge frames (5.1B) can be fastened by the screws (4.2) with the plates (4), as illustrated in Fig. 4 and 16.

This *new* invention is superior to the proposal in Chap. 10b.

In case of 2-door car one or several retaining plates (4) are welded to the corresponding plates (5.3) welded to to the front sides of impact beams (1B, 7B), as illustrated in Fig. 15.

In all Patent Applications door shell is not fixed to the structurally undersized impact rods, but to the door girder or to the lower section of frame in case of Roltra in Chap. 13. Proven as "practical advantage for adapting" for the assembly concepts outlined in Chap. A8a and A8b is the *method of fixing* the door shell with or without inner panel to one or several impact beams, if structurally necessary, additionally to reinforced or structural elements. On the other hand *door girder* is not needed anymore! If the outer panels of the adjacent doors will not fit to each other in conjunction with the chassis regarding the appearance, e.g. height differences in z-direction and gap differences in y-direction, adaptation can be carried out by releasing and fastening the screw couplings at assembly line. Employing this means of adapting saves costs and cuts reject rate! Whereby, in order to keep reject rate low, labour intensive, time consuming and costly operations must be conducted at the *conventional* door assembly.

A8a Door truss and door assembly concept

After the operation of flanging the outer and inner panels (8.7, 8.8. shown in Fig. 18) into a door shell and the operation of colour varnishing this door shell is transported by an AGV(Automatical Guided Vehicle) for further assembly process with regard to other door parts at a Production Cell outside of the assembly line. This AGV itself can serve as Production Cell.

Two assembly approaches are incorporated into the above-mentioned embodiment:

- Inserting the door truss at the AGV through the access opening of *lower* side of door shell in z-direction, termed as approach from the bottom.
- Lowering the door shell hanging at the door assembly line for the purpose of inserting the door truss through the access opening of *lower* side of door shell in z-direction, termed as approach from the top. The advantage over both Patent Applications (Chap. 7, 14) is to save at least one work cycle.

Over the Patent Application (Chap. 4) both approaches attribute another advantage to the possibility for locating a high-size window pane protruding above the lower window frame in the door truss before inserting through the access opening.

The operation of fixing door shell corresponds to the method in Chap. A8, resulting in the "practical advantage for adapting". Afterwards other door parts, later on the cover plates (8.1, 8.2), window guide channel frame (8.5), plastic cover (8.6), other covers, components and, in some cases, aggregates are attached to the door shell as being finally assembled. This door (8) is ready for being transported. Upon call this door will be brought to the assembly line, preferably by the AGV.

Each door truss is suited for this door assembly concept, while the following advantages are offered:

- Time saving for assembly and installation.
- Preventing accidents at the assembly line. With present assembling method outer and inner panels are hinged directly to the chassis being transported along the assembly line. In order to protect workers from being hit by the panels of approaching vehicles, outer and inner panels must be pushed into the chassis and all workers must move away from their danger spots then the vehicles may be transported.
- Smaller width of assembly line as space saving is attributed to the need of transporting only chassis without panels along the assembly line.
- Time-, space saving and fewer accidents are factors of cost cuts related to production and investment.

Both new door locks (Chap. A5a, A5b) as well as conventional door locks can be incorporated into this door assembly concept.

A8b Door truss and door assembly concept without inner panel

The same door assembly concept as in Chap. A8a either at a door assembly line or at an AGV can be applied to assembling a door truss *without* inner panel, but *with* an inner cover with bin (8.10) illustrated in Fig. 19, front cover (8.1), back cover (8.2), other door parts mentioned in Chap. A8a. The door (8) finally assembled is ready for to be transported upon call . This AGV itself can serve as Production Cell. The door truss (8.3), as illustrated in Fig. 19, in co-operation with the retaining blocks (15.2a, 15.3, 15.4) and the corresponding structural elements (6.1a, 6.2a) of window guides (6.1, 6.2) is a compound construction according to Chap. A7.

Just as in Chap. A8a, two assembling approaches at AGV or at the door assembly line are incorporated into the above-mentioned embodiment. The different operation of fixing outer panel instead of door shell corresponds to the method in Chap. A8, resulting in the "practical advantage for adapting". Upon call this door will be brought to the assembly line, preferably by the AGV.

Just as in Chap. A8a, each door truss is suited for this door assembly concept, while the following advantages are offered:

- The same as in Chap. A8a
- Cost saving due to eliminating inner panels, operation of flanging, cutting the production time and as well as eliminating the need for purchasing expensive flanging tools.
- Smaller permissibly manufacturing allowances for outer panels due to the single operation of punching out outer panels.
- Lower reject rate.
- In the case of rejection the costs of material and manufacturing are definitely lower than those for door shell consisting of outer and inner panels being flanged together.
- Less proneness to corrosion due to lack of flanged edges.

Both new door locks (Chap. A5a, A5b) as well as conventional door locks can be incorporated into this door assembly concept.

A8c Position of window gear in door truss

Referring to definition in Chap. A4 the door trusses (8.3, 8.4, 8.30, 8.40) illustrated in Fig. 18 and Fig. 19 differ from each other by

- open or closed cross sectional configurations of impact beams illustrated in Fig. 6 and 7,
- attaching rigidly the window guides (6.1, 6.2) to the recesses on the impact beams (1, 7 shown in Fig. 2) or to the impact beams (1, 7 shown in Fig. 4),
- and positioning the window gear (7.1) rigidly attached above or below to the lowest impact beam of the respective door trusses (8.3, 8.30) or (8.4, 8.40).

This methods of attaching rigidly window gear shows the way of positioning incorporated into the aforementioned door assembly concepts, independently from the door truss arrangement illustrated in Fig. 5.

A9 Side collision

The increase of dead and heavily injured occupants due to side collisions is attributed to lack of crumpling zone at side structural configuration, lack of intricate seat-belt system, lack of airbags and to the one-door system to protect against side impact energy.

From the load cases illustrated in Fig. 1, Chap. 8 and A7 and the state of deformation of that car involved in the above-mentioned accident the following countermeasures against collapse of side passenger cell can be formulated:

- Due to lack of crumpling zone the constructive improvements of exploiting the *whole* door thickness for reducing stress and increasing stiffness are significant. Those improvements were depicted in Chap. A3.
- The primary functions of springs are to eliminate vibration and impact in trains and car suspensions. The equation of Work by spring is expressed by Energy = Force x deflection. In BMW DE 4125299 patent application listed in Chap. 3 spring leafs are proposed as means to absorb side impact energy. All impact springs as P10, P11, P12, P13, P29 and P31 illustrated in Fig. 1, 6 and 7 can serve as soft crumpling zone to absorb side impact energy.
- Due to fewer number of supports and elements in x-y and z-x planes illustrated in Fig. 1 the structural elements of those embodiment mentioned in Chap. 6 and 15 are highly stressed or overstressed by the side impact energy depending on the magnitude. By employing the "Principle of load distribution" (Chap. N6, A6, A7 and Fig. 1, 23, 24) by means of those fourfold steps of increasing structural stiffness to a high number of supports and elements, stress and deflection of all parts are substantially reduced!
- If the cavity of the door shell has still space, incorporate the structural elements as window guides (6.1, 6.2, 6.1B, 6.2B) or the structural elements (6.1a, 6.2a, 6.1aB, 6.2aB) of window guides (6.1, 6.2, 6.1B, 6.2B) to the plan of laying out.
- Position one or several structural elements to the most structurally endangered area found out by evaluating the statistics on deformation due to side collisions.

A10 Door truss arrangement

By definition "door truss arrangement" as compound unit with regard to method of assembling in Chap A8 is resulted form two door trusses. Door truss arrangements from A1 to A10 are illustrated in Fig. 5. However, a new door truss arrangement can be created by the following approaches of:

- combining the front door truss with the back door truss of two different arrangements.
- accommodating additionally the structural elements (10.1, 10.2, 10.1B, 10.2B) and/or the structural elements (6.1a, 6.2a, 6.1aB, 6.2aB) of window guides (6,1, 6.2, 6.1B, 6.2B) owing to the space gain (Chap. A11). The basic of this new arrangement illustrated in Fig. 22 corresponds to A8.
- providing the structural elements (6.1a, 6.2a, 6.1aB, 6.2aB) of window guides for purpose of clamping with the roof and the vehicle floor via the corresponding clamping pairs referred to Chap. A7, as illustrated in Fig. 1 and 23. Each door truss arrangement is suited for this complementary step.

The door truss arrangements A3 and A4 are created by the combination of two door trusses. Each truss consists of one impact beam and structural elements, not drawn, with regard to the above-mentioned approach of accommodating due to the space gain.

A11 Space gain

Thanks to embodying the impact beam as bi-functioning part to replace door girder and structurally undersized elements space in the door cavity is gained. This space can be exploited for accommodating impact springs, other door aggregates and components, structural elements illustrated in Fig. 1, 22 and 23 to reinforce the door truss and to sustain the loading.

A12 Door lock with gliding and locking characteristics

To achieve an efficiently gliding characteristic during the operation of locking the inner edge of the locking plate (3.1) of door lock just after passing the block (2.1) must be in contact with the AB contour or CD contour of the block, at position A4 or C4 respectively, as illustrated in Fig. 12 and 10. Based on "point to point contact" the locking plate being pressed against the contour by the force of the spring glides along the contour and then snaps in the groove of the block end. During this operation the retaining orifice may not touch the contour.

Fig. 12 shows the trajectories, clearances and the cross section through the blocks and impact beams for the purpose of illustrating the position of the door in the state of closing.

This *new proposal,* not yet invented in any Patent Application, has the following advantages:

- The property of locking is improved by the gliding characteristic which is *smoother* than snapping characteristic of the lock wheels of conventional door locks.
- With conventional door lock the translatory movement caused by activating the lock knob or switch must be converted into a rotatory movement. However, with new door lock only a translatory movement is necessary. Hence, it saves cost due to *fewer* parts.
- The conventional door lock assembled to the side of the post section makes it *far easier* for burglars to reach. However, as additional security against burglary as well as vehicle theft the way of accommodating the locking plate *behind* impact beam makes it difficult to break into from outside of door.

A13 Adjustment

In order to meet small tolerance zone with respect to 1st, 2nd, 4th requirements in Chap. A5a the work of adjusting the clearances is carried out from outside of the car body by

- rotating the eccentric or centric elliptical ring (2.3 or 2.3a). Small holes on the rim of all rings shown in Fig. 14, 12, 13, 15, 16 are provided for rotating by inserting a rod as tool
- and/or correcting the length of spacer (2.4) by removing or adding several washers.

A14 Tolerance zone

Impact beam with retaining function (2.1a, 2.1aB) and structural elements with retaining function (15.1 to 15.5a, 15.6) can be provided with appropriately large tolerances (S3, S4 shown in Fig. 12 and 17), which are *larger* than the clearances (S1 and S2) responsible for the proper locking. Concerning the condition of "appropriately large tolerances" it is of interest to remark that the state of clamping between retaining block / orifice and retaining block / hole and retaining hook / reinforced rod must still be ensured on collision and/or overturn.

The fact, that no contact has taken place during the operation of door-locking, is substantiated by the trajectories of the outer nodes of retaining orifice "21.. 24" and "31..34" illustrated in Fig. 12 and 13.
For this reason the effort to meet the tolerances is focused particularly on the impact beam with locking function because of its smaller tolerance zone. Fig. 15 and 16 illustrate in detail the locking mechanism with regard to a tolerance zone from +2 to -2 mm in y-axis for door of compact car class.

However, it can happen that the operations of adapting according to Chap. A8 and of adjusting have been conducted, but in vain with regard to the chassis appearance referred to in Chap. A8. As three constructive means outlined in Chap. A5a one or two parts of the retaining block (2.1, 2.1B) and/or the retaining orifice must be changed in order to pass the appearance-control by carrying out those operations again.
Evidently, the tolerances for new invented door locks are much *easier* to meet than those for conventional door locks.

A15 Standardisation to reduce the number of impact beams and tools

In order to limit the number of impact beams used for four different vehicle classes (small or compact, middle, large, luxury) referred to M1, M2, M3 and M4 classes illustrated in Fig. 21 the method of standardisation is employed by

- varying the position of the beam with asymmetrical shape. The beam (1.) in one car of the M1 class is in a mirrored position to the other. Both beams (2.) of the M3 and M2 classes are differently positioned to the window guides.
- nesting of beams with respect to the approach in Chap. A1. Three united beams of the M3 and M4 classes are nested from two beams (1., 3.), respectively.

The study yields a result that only three beam types are needed for doors of four different vehicle classes. On basis of maintaining the same number of doors being manufactured, limiting the beam types generates a higher number of each type to be ordered. Particularly, by use of standard beams costs of tooling, manufacturing and stockpiling will be cut eminently.

A16 Verifying for application and fitness

On basis of the door size of compact car class the following studies are covered:

- Accommodating the door parts in the door consisting of the impact beams with big-sized cross section illustrated in Fig. 12, 15, 16 and 17 with regard to door truss and door assembly concept.
- Fixing the back and front doors to the chassis by means of bolting or screw coupling from outside (Fig. 3) as well as from inside (Fig. 16) of the car body,
- Assembling the adjacent door trusses into a compound construction illustrated in Fig. 16,
- The state of clamping between the impact beams and the corresponding retaining blocks illustrated in Fig. 15, 16 and 17, between the structural elements and the corresponding retaining blocks or orifices illustrated in Fig. 1 and 23 and between the retaining hooks and the reinforced rod illustrated in Fig. 24 on collision and/or overturn,
- The state of clamping between the door hinge frames themselves by means of standard parts as round head rivets and adapter sleeves for heavy duty illustrated in Fig. 16 on collision,
- Preserving the tolerances and operation of adjusting from outside of the car body illustrated in Fig. 12, 13, 15, 16, 17 and 23,

- Spatial movements of the outer nodes of the retaining orifice and of the locking plate on rotating the door about the door hinge bolt illustrated in Fig. 11, 12, 15, 16 and 20,
- Low-cost construction of the retaining blocks with locking function illustrated in Fig. 20,
- Opening of the front door to the car parts by rotating the door about the door hinge bolt illustrated in Fig. 16,
- Opening of the back door to the car parts by rotating the door about the door hinge bolt illustrated in Fig. 16,
- Standardisation to reduce the number of impact beams and tools illustrated in Fig.21,
- Accommodating an impact spring in the door shell and attaching it to one or several impact beams illustrated in Fig. 1, 6 and 7,
- Using standard parts to save costs and
- Two modular door assembly Concepts illustrated in Fig. 18 and 19.

Claims

1. An impact beam (1, 7, 1B, 7B) with retaining function or with retaining and locking functions characterised in that:

- a door hinge frame (5.2, 5.2B) is rigidly attached to the front side of the terminus of the said beam referred to S1 configuration by welding or gluing operations or screw couplings. S2, S3 S4 and S5 configurations show the other operations of assembling
- and the other terminus of the said beam is provided with a single or tandem retaining orifices for the purpose of telescoping the retaining block (2.1, 2.1B, 2.1a, 2.1aB, 2.1A) over the corresponding orifice(s) without contact on the operations of opening as well as closing door. In oder to ensure the state of clamping or retaining on collision and/or overturn a tolerance zone is designated for each mounting pair of retaining block / orifice and retaining block / hole.

Glass fibre reinforced material, non-metal material and compound material are suitable for material of the said beam.

2. A shape for a single or tandem retaining orifices according to Claim 1 characterised in that the said orifice corresponds to any one of the closed planes of circle, ellipse, rectangle and trapezoid referred to Q1, Q2, Q3 and Q4 configurations.

3. A method of structurally modifying an orifice according to Claims 1 and 2 characterised in that a reinforced plate (1.1a and/or 1.1b) is welded to the surface of the terminus side before machining an orifice through this side, or tandem orifices through all sides.

4. A method of nesting two or several impact beams into united beam according to Claims 1 and 3 characterised in that those beams are rigidly attached together by welding or gluing operations or screw couplings.

5. An arrangement to guide the window pane (6) according to Claims 1 and 4 characterised in that the window guides (6.1, 6.2, 6.1B, 6.2B) are rigidly attached to the respective beams by welding or gluing operations or screw couplings for the purpose of guiding the said window pane:

- through the recesses on the impact beams (1, 7) or
- at the impact beams (1, 7) or
- between the impact beams (P2 and P3 configurations).

6. A method of attachment according to Claim 5 characterised in that the window guides or the structural elements of the window guides are rigidly attached to the corresponding impact beams by welding or gluing operations or screw couplings.

7. A cross section of impact beam according to Claims 2, 3 and 5 wherein the cross section corresponds to:
- any one of the open cross sectional configurations (P1 to P9, P22 to P26, P29 to P35)
- or any one of the closed cross sectional configurations (P20, P21, P27, P28)
- or an arbitrarily closed cross sectional configuration created by the operation of punching out or burning any beam with closed cross sectional configuration
- or an arbitrary configuration of united beam assembled by nesting two or several impact beams.

8. An assembly of door truss according to Claim 7 wherein the said door truss comprises
- one or several impact beams,
- if structurally necessary, with supplements as the reinforced elements (10.1, 10.2, 10.1B, 10.2B) and/or the structural elements (6.1a, 6.2a, 6.1aB, 6.2aB) of window guides and/or impact springs.

9. An operating mechanism for clamping to Claims 6 and 7 characterised in that in the event of collision and/or overturn the state of clamping is ensured by the mating pairs of clamping means as retaining blocks / orifices, retaining blocks / holes and retaining hooks / reinforced rod, preferably retaining hooks / beam rod.
Glass fibre reinforced material, non-metal material and compound material are suitable for material of the said parts.

10. A mechanism of the retaining block (2.1a, 2.1aB, 2.1A) according to Claim 9 wherein
- the variational constructions of the said block as H1, H2 and H3 comprise standard parts with exception of the silencing stop ring (2.11). The variational construction as H1 consists of a hexagon socket head screw (2.10) ref. to DIN 912, a big washer (2.13) ref. to DIN 9021, a silencing stop ring (2.11) and a number of washers ref. to DIN 125 as spacer (2.12) responsible for the clearances (S3 and S4).
- or another variational construction by use of standard screw couplings as H4 comprises a spacer (2.12), a nut and a washer (2.13).

11. A mechanism of the retaining block (2.1a, 2.1aB, 2.1C), solely, with locking function according to Claim 10 wherein the following constructions of the said block are in effect by blocking:
- on moving the pin (2.30) guided by two silencing bushings (2.31) from its position "O" (Open) into "L" (Lock). This pin is secured by two retaining washers for shaft (2.32) ref. to DIN6799. To shorten the assembly time all parts are assembled into one unit mounted (2.33), then bolted with silencing intermediate layer (2.34) to the impact beam (1, 1B).
- or on rotating the silencing plate (2.16) guided about the axis of bolt (2.19) from its position "O" into "L". This plate with silencing intermediate layer (2.17) is secured by the nut with thread security (2.18) or by double nuts to prevent it from coming loose.

Both constructions, similar to H1, are supplemented with the silencing rings (2.14, 2.15).

12. A retaining block (2.1, 2.1B) with locking function and gliding property according to Claim 9 wherein the contour of the said block is characterised
- by any one of the 21 blocks from K1 to K7, from K1a to K7a, from K1b to K7b
- or by the hull corresponding to cylinder section, truncated cone, spherical section, hyperbolical section, one sheet or elliptically parabolical section, whereby the number of various blocks increases, greater than 21.

For purpose of operating from outside of the car body the front side or the head of block is provided with a means to fasten as hexagon socket head of a screw ref. to DIN 912, cross slotted, square slotted or slotted head etc.

13. A mechanism for adjusting according to Claim 12 characterised in that small holes are provided on the rim of the said adjusting ring (2.3) for purpose of inserting a rod as tools to adjust clearances from outside of the car body. The said rings from M1 to M3, from M1a to M3a, from ML1 to ML3 and from ML1a to ML3a are characterised by various parameters and shapes for adjusting purpose.
For the said rings is the use of soundproofing (silencing) material recommendable.

14. A mechanism for guiding the locking plate (3.1) according to Claim 12 wherein the movement of the said plate in an axis is governed by
- the guiding pins (1.2 and 1.3) corresponding to F1 or F2,
- or being in light contact with the sides of U-shaped locking plate (1), whereby as bi-functioning part the pin (1.2) is designated for retaining and positioning the said plate.

15. A mechanism of the retaining block (2.1, 2.1B) according to Claims 12, 13 and 14 wherein the outer (3.8) or inner (3.1) edge of locking plate or the edge of locking pin (3.9) glides along the corresponding contour of the said locking, guiding, retaining block (2.1) without contact between the said block and the retaining orifice upon opening as well as closing door.

16. A door locking mechanism for interlocking according to Claim 15 characterised in that the said mechanism latches itself on the state of locking in order to secure against the movement of locking plate energised by kinetic energy on collision and/or overturn as follows:
- by blocking means (D1), whereby the plate (3.2) is projected in the groove (3.3) of impact beam
- or by blocking (D2) together the groove (3.4) of locking piece (3.1) with the corresponding groove of impact beam
- or by blocking (D4) together the hole (3.5) of locking piece (3.1) with the corresponding hole of impact beam
- or by blocking (D3) the cut-out (3.6) with the corresponding guiding pin (1.2) of impact beam whereas this pin is engaged in the cut-out upon pulling up the locking piece (3.1).

By activating the said mechanism to open door this interlocking condition is released immediately.

17. A door locking mechanism for interlocking according to Claims 11 and 15 characterised in that the said mechanism latches itself on the state of locking in order to secure against the movement of locking plate energised by kinetic energy on collision and/or overturn as follows:

- self latching in any direction, e.g. in z- direction being activated by the said mechanism while the locking plate (3.1) moves in another direction, e.g. in y-direction
- or self latching being activated by the said mechanism in the same direction as opening direction of the locking plate (3.1).

Alternatively thereby, at least one of these both states is always in charge of interlocking on collision and/or overturn. By activating the said mechanism to open door this interlocking condition is released immediately.

18. A mechanism of the retaining block (15.1 to 15.5a) with exception of (15.4a) according to Claim 9 wherein the said mechanism comprises a screw (15.14), a bushing (15.11), a number of washers built into one spacer (15.12) and a washer with a large outer diameter (15.23).

19. A shape for a retaining orifice of the structural element or the reinforced element or panel according to Claim 9 characterised in that the said orifice corresponds to any one of the closed planes of circle, ellipse, rectangle and trapezoid referred to Q1, Q2, Q3 and Q4 configurations.

20. A mechanism of the retaining hook (15.6) according to Claim 9 wherein the said mechanism comprises a hook (15.20) with inner diameter d_1 and gap s_1, a screw (15.21), a number of washers built into one spacer (15.22), a coil spring washer (15.24) and a nut (15.25).

21. An operating mechanism for clamping according to Claims 18, 19 and 20 wherein in the event of collision and/or overturn the state of clamping is ensured by the said mechanism as any one of the following mating pairs of the clamping means:

- the retaining block (15.1) screwed into the reinforced plate of L-shape of A-post section and the oblong hole as retaining orifice of structural element (6.1a). This A-post section, the reinforced panel (17.1c) being bounded along the roof and transverse girder (17.2d) of both A-post sections are welded together. This construction is applicable too for the structural element (6.2aB) in association with the C-post section.
- and/or the retaining block (15.2a) screwed into the block (6.11) of structural element (6.1a) and the oblong hole as retaining orifice of reinforced panel (17.1) being bounded along the roof. This panel, the reinforced plate (17.2a), L-shape of A-post section and transverse girders (17.2, 17.2b) of both A-post sections are welded together. Upon cost saving the reinforced plate (17.2a) as bi-functioning part can replace both girders (17.2, 17.2b). This construction is applicable too for the structural element (6.2aB) in association with the C-post section.
- and/or the retaining block (15.2) screwed into the structural element (6.2a) and the retaining orifice of reinforced panel (17.1a) being bounded along the roof. This construction is applicable for clamping of the retaining block (15.2) of structural element (6.2aB) in the corresponding retaining orifice.

- and/or the retaining blocks (15.3, 15.3a) screwed into the corresponding sides of U-shape block (17.3) and the corresponding oblong holes as retaining orifices of structural elements (6.2a, 6.1aB). As connecting element between both B-post sections and the roof this U-shape block at the B-post section, the reinforced plate (17.1b) being bounded along the roof and transverse girder (17.2c) of both B-post sections are welded together.
- and/or the retaining block (15.4) screwed into the reinforced plate of reinforced panel (18.1) being bounded along the vehicle floor and the retaining orifice of structural elements (6.1a). This construction is applicable too for the structural elements (6.2a, 6.1aB, 6.2aB).
- and/or the retaining block (15.4a) from rivets e.g. round head rivet ref. DIN660 attached rigidly to the reinforced plate of reinforced panel (18.1a) being bounded along the vehicle floor and the retaining orifice of structural elements (6.2a).
- and/or the retaining blocks (15.5, 15.5a) screwed into the corresponding sides of U-shape block (18.3) and the corresponding oblong holes as retaining orifices of structural elements (6.2a, 6.1aB). As connecting element between both B-post sections and the roof this U-shape block at the B-post section, the reinforced plate (18.1b) being bounded along the vehicle floor and transverse girder (18.2) of both B-post sections are welded together. To the U-shape block (18.3) the case of seat belt (26) is attached rigidly.
- and/or the retaining hooks (15.6) screwed into the structural elements (6.1a, 6.2a, 6.1aB, 6.2aB) and the reinforced rod (17.1d). This rod and the transverse girders (17.2e, 17.2f, 17.2g) of both A-, B-, C-post sections are welded together.

By applying the associative rule to both clamping members, the placement of retaining block or retaining orifice to the structural element as well as to the reinforced panel as well as to the U-shape block is in either way presents no problem.
Any reinforced plate attached rigidly to the reinforced panel by welding extends beyond the retaining orifice as well as retaining hole.

22. An operating mechanism for clamping according to Claims 7 wherein in the event of collision and/or overturn the state of clamping is ensured by the said mechanism as clamping means consists of a standard part (5.6, 5.7, 5.6B, 5.7B) attached rigidly to one door hinge frame and a retaining hole or orifice of the other door hinge frame. Round head rivets (5.6) ref. DIN660, adapter sleeves for heavy duty (5.7B) ref. DIN1481, pins, bolts or screws are suitable for standard parts.
Glass fibre reinforced material, non-metal material and compound material are suitable for material of the said parts.

23. A method of assembling the door according to Claim 8 wherein the said door is
- screw coupled from outside of the car body. For assembling the said back door the hinge frames (5.2B) are bolted together with the plates (5.4B) welded to the front sides of impact beams (1B, 7B). This said method is applicable too for bolting together with the plates welded to the front sides of impact beams (1, 7) of the front door.
- or screw coupled from inside of the car body. For assembling the said back door the hinge frames (5.1B) are fastened together with the plates (4) by the screws (4.2).

24. An arrangement of door truss or door according to Claim 23 wherein any one of the said arrangements from A1 to A10 consists of the adjacent door trusses or doors. Whereas new arrangement can be created by
- combining the front door truss with the back door truss of two different arrangements.
- accommodating additionally the structural elements (10.1, 10.2, 10.1B, 10.2B) and/or the structural elements (6.1a, 6.2a, 6.1aB, 6.2aB) of window guides (6.1, 6.2, 6.1B, 6.2B) in the existing arrangement.
- providing the existing arrangement with the structural elements (6.1a, 6.2a, 6.1aB, 6.2aB) of window guides for purpose of clamping.

25. A compound construction of a whole car side according to Claims 10, 22 and 24 wherein in the event of collision and/or overturn the said construction interconnects all post sections, if available the slide door, and
- the adjacent doors by the clamping means in case of 4-door vehicle
- or by the clamping means of beams of the front door clamping in the retaining plates (4) welded to the front sides of the impact beams (1B, 7B) in case of 2-door vehicle, respectively.

26. A compound construction of both car sides according to Claims 21 and 25 wherein in the event of collision and/or overturn the said construction interconnects those both car sides, the roof (17), if available the tailgate door, and the vehicle floor (18) via the corresponding clamping pairs.

27. A compound construction of both car sides with locking function according to any one of Claims 11, 15 and 26 wherein the said construction is provided with
- door locks without gliding property
- or door locks with gliding property
- or conventional door locks

28. A compound construction of both car sides with locking and interlocking functions according to Claims 15, 16 and 26 wherein the said construction is functionally provided with self latching being activated by the door locking mechanism after the operation of locking.

29. A compound construction of both car sides with locking and interlocking functions according to Claims 15, 17 and 26 wherein the said construction is functionally provided with self latching being activated by the door locking mechanism after the operation of locking.

30. A modular concept of door assembly according to Claim 8 characterised in that the said concept is applied for assembling door by

- inserting the door truss through the access opening of lower side of door shell, in term of the from the bottom approach,
- or lowering the door shell hanging at the door assembly line for the purpose of inserting the door truss through the access opening of lower side of door shell, in term of the from the top approach.

The door shell is fixed to one or several impact beams, if structurally necessary, additionally to reinforced or structural elements.

31. A modular concept of door assembly without inner panel according to Claim 8 characterised in that the said concept is applied for fixing the outer panel as door shell without inner panel to one or several impact beams, if structurally necessary, additionally to reinforced or structural elements.

32. A method of final assembly for door according to any one of Claims 30 and 31 characterised in that the said method is employed to mount and attach rigidly the rest door parts as the cover plates (8.1, 8.2), window guide channel frame (8.5), plastic cover (8.6), in case of Claim 31 the cover with bin (8.10), other covers, components and, in some cases, aggregates to the door shell so that the door (8) is finally assembled.